كلية التربية - الفرقة الرابعة - فيزياء
مقرر الرنين المغناطيسي ١٢/٤/٢٠٢٠

تابع محاضرة Torque and Larmor Precession

(بتاريخ ١٠/٤/٢٠٢٠)

We have seen in the last lecture that an a.c magnetic field $\vec{B}_1$ Causes a torque $\vec{\tau}_1$ (Fig. 3) which tends to keep the angle Θ constant. There are damping forces (looks like friction forces) that tend to decrease Θ. The static field B_0 is about 1 T, but B_1 is much smaller ($\sim 10^{-4}$ T). The balance between the damping torque and the torque τ_1. At resonance the angle Θ will be small ($\sim 1^\circ$).

In practice one changes B_0 until maximum absorption of energy occurs from the field B_1.

As we have seen before, electron paramagnetic resonance takes place at $f \simeq 10$ Ghz $\simeq 10^{19}$ hz while nuclear magnetic resonance (NMR) takes place for frequencies about 10 Mhz $\simeq 10^{7}$ hz.

c.c. / ٤/١٢

(2)

رابعة فيزياء - رنين مغناطيسي

Question: Which of the following nuclei have integer spin, non-integer spin and Zero spin:

$^{1}_{1}H$, $^{7}_{3}Li$, $^{10}_{5}B$, $^{11}_{5}B$, $^{13}_{6}C$, $^{17}_{8}O$, $^{14}_{7}N$,

$^{23}_{11}Na$, $^{27}_{13}Al$, $^{4}_{2}He$, $^{12}_{6}C$, $^{16}_{8}O$, $^{29}_{14}Si$

Problem: Calculate Larmor frequency for an electron in a 1 T magnetic field

Question: Define each of the following physical quantities and give its units:
Angular momentum, Torque, Power, Magnetic moment, Magnetization, Larmor frequency, Partition function and Paramagnetic saturation.

Question: What is the difference between NMR (Nuclear Magnetic Resonance) and ESR (Electron Spin Resonance). Show that the first takes place at the radio frequency and the second at the microwave frequency.

رابعة فيزياء - رنين مغناطيسي ١٤/١٢ .٢٠٢٠

Problem: a) Use the expression:

$$M = M_0 \tanh \frac{\mu B}{kT}$$

where $\mu = \mu_B$, and $B = 1\,T$, to find the temperature at which 70% saturation is achieved.

b) For <u>protons</u>, what is the temperature at which 70% saturation in the same field.

Question: a) A proton has spin $1/2$ and two spin states. In a magnetic field of 1T find the probability of the first (ground) level, at $T = 4\,K$.

b) Repeat a) for $T = 300\,K$.

c) Plot these two probabilities as function of $\frac{\mu B}{kT}$.